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Transportation Mobility and Its Influence on Accessibility in Israel

A Comparative Study

Yoram Ida and Gal Talit

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Abstract

The amount of mobility differs between countries and between cities and impacts on the daily quality of life in these places. This study examines the amount of mobility in the transportation in Israel, with an emphasis on the residents of the country's largest metropolitan area, the Tel-Aviv metropolitan area, in comparison to other metropolitan areas in the Western world. A distinction is made between two main means of transportation, private vehicles and public transport.

It turns out that the mobility of private vehicle users in the Tel-Aviv metropolitan area in 1995 was relatively good compared to other cities, and the mobility of public transportation users was relatively inferior. The developments that have taken place since then in Israel point to a relative worsening in the transportation situation for users of both means of transport. The paper discusses the types of changes as well as the reasons for these changes and serves as a basis for recommendations central to the issue of accessibility to transportation in Israel. The researchers call for a change in the public policy that gives preference to private vehicle users over public transportation users. Ultimately, the current policy is harmful to economic efficiency and increases the inequality in society.

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Executive Summary

"*Transportation is the linchpin to the quality of life*."[1]

Accessibility is a key factor in the overall quality of life and in modern, large cities, in particular. It is measured by the relative ease of reaching products, services, activities, and destinations. Efficient transportation is a necessary condition to accessibility that improves the amount of mobility, as measured by the number of trips, in distance and speed. Good mobility allows reaching places like work, studies, leisure time activities, and shopping with relative ease.

The basic assumption of the study is that mobility levels are expected to differ between countries and cities, and have an influence on the daily quality of life of local residents and tourists. On the basis of this assumption, the study seeks to examine the amount of transportation mobility in Israel, with an emphasis on the Tel-Aviv

* Thanks to Professor Dan Ben-David and Professor Ayal Kimhi for their helpful comments during the writing of this work.

1 This was said by Ms. Susan Schruth, acting head of the Office of Civil Rights, Federal Transit Administration. The American Office of Transportation website: http://www.tfhrc.gov/pubrds/fall94/p94au18.htm, viewed 15 June 2009.

metropolitan area residents, the largest metropolitan area in Israel, in comparison to other Western metropolitan areas primarily in Western Europe. The comparison differentiated between two types of main transportation modes, private and public transport.

The findings of the research show that mobility of those with private transportation in the Tel-Aviv metropolitan area in 1995 was good relative to other cities, while the mobility of public transportation users was relatively less good. Developments in transportation mobility from 1995 to 2006 indicate a worsening in the relative situation of private vehicle users primarily due to the rapid rise in population and improvements in the standard of living that increased the use of private vehicles. In the public transportation realm there was a worsening of mobility in these years, mainly as a result of a poor fit between the supply of public transportation and the changing demands of the growing population.

The study serves as a basis for policy recommendations primarily on issues of accessibility in transportation in Israel. Central among them is a call for change in public policy that currently gives preference to private vehicles at the expense of public transportation. The current policy harms economic efficiency and increases inequality in society.

1. *Introduction: On Mobility and Accessibility – Transportation Options*

The term accessibility expresses the relative ease with which one can reach products, services, activities, and destinations, under the rubric of "opportunities." In addition, it is possible to define "accessibility" as the potential for interaction and exchange. In the terms of potential, accessibility is the opportunities that are within reach; in the terms of activities, the reference is to opportunities that can be actualized (Engwicht, 1993; Hansen, 1959). Individuals who are not at a given time using a mode of accessibility are still able to give a value to the availability of options for future use (value option). "Mobility," on the other hand, expresses the physical movement that is measured in number of trips, distance and speed. Raising mobility increases accessibility when all else remains fixed, because as the ease of the trip rises, there is also an increase in the number of places that can be reached. Many variables influence mobility and amongst them: the quality of existing transportation services and their cost, the variety of means of transportation available to the population, and the level of integration between them.

It is possible to evaluate mobility from a number of perspectives: from the point of view of special interest groups in the population, from the transportation mode perspective, as well as from the point of view of location or type of activities (for work, shopping, entertainment, and so on). Transportation planning presumes, in general, that an increase in mobility is useful and desirable, although it has socioeconomic and environmental costs that are associated with it (Litman, 2007). Therefore, in the optimum market, it is best to minimize the individual transportation significantly, and to rely more on alternate transportation methods. It is possible to reach the same levels of mobility relying on strategies other than private vehicles,

including walking, bicycling, ride-sharing, and public transportation. Reform in this area would give incentives to commuters for using alternate modes of transportation. Families could be given incentives to choose their residence within a reasonable walking distance of schools; and for businesses, locations should be chosen that are highly accessible by public transportation. With this background, different reforms to improve the efficiency of transportation markets and road usage include, in general, use of congestion tolls and parking fees (Litman, 2008).

The research focuses on examining the measure of mobility in Israel, with the underpinnings of the analysis being the assumption that increasing mobility also increases accessibility. The study checks the mobility in the Tel-Aviv metropolitan area on two levels: mobility by means of motorized vehicles and trains,[2] examined firstly in comparison to metropolitan areas in other Western countries, primarily in Western Europe (with comparative data from 1995); and then examining the changes in mobility in Israel in the years 1995-2006. Because there is a measure of interchangeability between different methods of transportation, the work checks between two main means of transportation which can be substituted for the other: private motor vehicles and public transportation, including all means of transportation in the different cities.

Section 2 is a literature review of characteristics of transportation. Section 3 presents indicators in transportation development and, in this context, the methodology, sources of data and the data used are presented. Section 4 shows the findings about the development of transportation in Tel-Aviv and in the metropolitan areas of the Western countries that were part of this study. Section 5 is the summary and discussion on accessibility of transportation in Israel.

[2] Due to limitations of the data, this work will not deal with mobility through walking on foot, riding bicycles, etc.

Section 6 presents policy recommendations in the field of transportation in Israel.[3]

2. Characteristics of the Transportation System – Literature Survey

2.A. The Demand for Transportation

The demand for transportation describes the level of mobility and accessibility that people are interested in having under different conditions. The total activities of transportation portray the level of mobility and accessibility that people actually use. The majority of people do one to three daily trips outside of the home, while for commuters[4] the average of trips to school, work and various other needs is greater than the overall average. Dividing the population by level of income shows differences: those with higher income make more daily trips than those of low income. It is possible to categorize the demand for transportation by the following five characteristics:

1) **Demographic variables**: age, income, employment, gender, and so on.
2) **Purpose**: work, study, personal business, leisure activities, and so on.
3) **Destination**: educational institutions, place of employment, stores, restaurants, parks, friends, family, and so on.

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[3] A number of graphs in this work are based on the publications of the Central Bureau of Statistics (CBS). Thanks to Yulia Cogan from the Taub Center for preparing the graphs presented in this work.

[4] This is the name given to travelers who on a regular daily basis go from their residence, which is not in the city, to their work, which is in the city and back within the same day to their residence.

4) **Time**: hours, days, seasons.
5) **Means of transportation**: walking, bicycle riding, private motor vehicle, public transportation. Dividing the trips between modes of transportation (the ratio of trips by different transportation means) is influenced primarily by variables like availability of a car and the quality of alternate means of transportation.

Individuals choose a desirable level of mobility (Mokhtarian and Salomon, 2001) that generally includes a variety and combination of transportation options: walking, bicycle riding, private vehicle use, public transport (Handy, 1993). Mobility can be a form of pleasure all its own. Thus, for example, people tend to combine various modes of transportation, like driving on country roads as part of a vacation. Even business trips can at times be extended due to the pleasure of travel. Nevertheless, research on travel time indicates that most people prefer to keep the travel time of business trips to a minimum (Litman, 2006).

2.B. Mobility

It is accepted in transportation planning to estimate mobility in the transportation system using indicators of average travel time and delays caused by congestion (Litman, 2001). Congestion limits mobility and so use of high capacity carriers and their priority treatment over private vehicles can decrease congestion and improve mobility without increasing the overall total (in travel distance) of vehicles. Different modes of transport have differing speeds that also influence the various levels of mobility (Krizek, et al., 2007)

2.C. Transportation Options

Transportation options, which include both mobility options and a variety of modes of transport, express the amount and quality of means of transportation and services available in a given situation. In general, improving transportation options increases mobility and as a result, also, accessibility. The tendency is to take into consideration primarily the speed of travel, although there are other important factors like the ease of travel. Specific models use measures of accessibility for particular modes of transit, for example, estimates of accessibility of a given transportation mode use measures of service level that include a combination of frequency of travel and quality of transit stops (Minocha et al., 2008).

2.D. User Information

Quality of information has an influence on mobility and accessibility measures for different transportation modes. For example, drivers in private vehicles need information on travel routes, road conditions, road congestion, and parking availability. Public transportation users need information about travel routes, timetables, tariffs, and accessibility to specific destinations. There are many ways to supply travel information – through maps, brochures, internet sites, and cellular phones. Advanced communication systems can significantly improve the availability of information using vehicle navigation systems and internet sites that publicize specific information on public transport, and real-time information regarding location and timetables for public transportation, and so on. The effectiveness of information is dependent on how informed the potential users are, the accessibility of information, as well as the actual use of the information (Litman, 2006).

2.E. Integration of Modes of Transportation, Terminals and Parking Lots

Accessibility is influenced by the quality of the integration of transportation systems, as expressed in the ease of moving between various transportation options, in the quality of public transportation terminals and ease of parking. Motorized travel is generally integrated, with most destinations having a surplus of parking, generally free or at a relatively low cost. Likewise, transportation hubs are generally planned in such a way that they are easy to use and with good information systems. Nevertheless, some places can at times be inaccessible to public transportation, and sometimes bus stations or train stations are inaccessible, particularly for those with disabilities, children and those carrying heavy cases.

2.F. Affordability

Affordability is expressed such that the monetary expenditure of the user is not too high, especially in relation to basic accessibility (that is, a trip that has a high social value). Private and social factors influence affordability, so, for example, drivers are influenced primarily by their ability to purchase a private vehicle, and others are influenced by the ability to buy public transportation and taxi services. Affordability can be measured in a few ways:

1) Quality and cost of using various means (in particular modes of transportation for use by those of limited income).
2) The ability to purchase a residence in more accessible locations.
3) The expenditure on transportation from the overall family income.

When households with low income have to spend more than 20 percent of their budget on transportation, this is a very high expense. Workers with low income, who live in places that are dependent on private transportation, in general absorb high transportation costs (VTPI, 2006). In such cases the tendency is to buy used vehicles that

are unreliable with high maintenance and insurance costs, with more frequent unexpected problems, a greater danger of accidents, and vehicles that are less road-worthy. Current research in this area developed a measure that expresses affordability, which combines transportation and living expenditures (including car ownership and public transportation costs), in order to estimate the expenditure burden of choosing to live in different residential areas. In a study that was conducted in this field (Litman, 2006) it was found that the average rate of expenditure dedicated to living expenses and transportation totaled some 48 percent. For families with an annual income of less than $50,000, the combined burden reaches 57 percent, with a lower rate for those living in central areas versus those in outlying areas.

In planning transportation it is accepted to recognize a number of factors that influence affordability: costs of maintaining a car (petrol, taxes, parking) and public transportation costs. Along with this, there is a tendency to ignore certain factors: primarily, the importance of non-motorized means of transportation in the integration between various transportation methods and location factors that push those of low income to live in places that make them dependent on private transportation with its accompanying high costs.

2.G. Planning and Administering Roads

Different components in planning and administering roads influence measures of mobility and accessibility. Oftentimes, planning involves choosing between a number of different means. For example, road planners have to choose between allocating road area to regular traffic, bus lanes, bike lanes, parking spaces, sidewalks, and the like. The choice of wide and straight roads, with a minimum of intersections and a minimum of lanes, gives preference to vehicular traffic but it

could be difficult or unpleasant for pedestrian traffic, as well as for public transportation.

2.H. Preference for Certain Modes of Transit

The efficiency of transportation systems increases when priority is given to travel that is more important, as expressed, for example, in the readiness of users to pay or the preference for more efficient modes of transit like high capacity carriers.

1) Pricing mechanisms can create preference for high priority travel based on the user's readiness to pay. For example: congestion charges on routes with high congestion serve to enable trips that are high priority and displace the relatively unimportant trips; or high pricing for parking places allows access to more convenient parking for a price.
2) Giving priority to high capacity carriers (diamond lanes) on high-congestion routes in order to displace vehicles that are less efficient in terms of their capacity. These types of steps are obligatory in order to insure that investments in road widening will in fact bring down the traffic congestion (Litman, 2007). Without giving priorities, these types of investments are likely to create little net gain for consumers, or even negative net gain for society in terms of growing negative externalities that results from traffic congestion, accidents, air, and noise pollution. Giving priority through congestion charges and priority lanes for high-capacity carriers is meant to improve accessibility by decreasing the total number of vehicle trips.

2.I. Government Involvement in Transportation

The area of transportation, in general, and public transportation, in particular, are characterized by high level government involvement,

which is essential for reasons of improving economic efficiency and promoting equality.

1) **Economic Efficiency**

The transportation branch is characterized by significant market failures, primarily due to negative externalities like air pollution, traffic congestion, and safety issues that are caused to a great extent by increased private vehicle use (Hensher and Wallis, 2005). The demand for public transportation in the world, and in Israel as well, is characterized by a continuous downward trend over time. This trend is explained primarily by the dispersion of activities that together with increased private vehicle use make it more difficult to give an answer through public transportation. On the other hand, rising trip prices, a lowering of the service for the traveler, poorly planned transit lines, and a lack of technological variety for essential travel, also damage the level of suitability of the supply for the changing user's demands.

The trends in public transportation travel and private vehicles in Israel are shown in Figure 1. It presents the trends as measured against the base year of 1980 (with a value of 100 assigned to 1980).

The figure indicates that the rise in bus mileage[5] in Israel is less than the increase in population, and significantly less than the mileage of private vehicles. In addition, there is a claim that the demand for buses is even less since according to the findings of various studies, the average of travelers to bus kilometers over time has fallen (Grounau, 1997). In this situation traffic congestion rises and because of this there is also a rise in the accompanying negative externalities. Decreasing negative externalities requires, on the one hand, a relatively heavy taxing of private vehicles, for instance, through congestion charges in overcrowded areas – a tax that cannot be

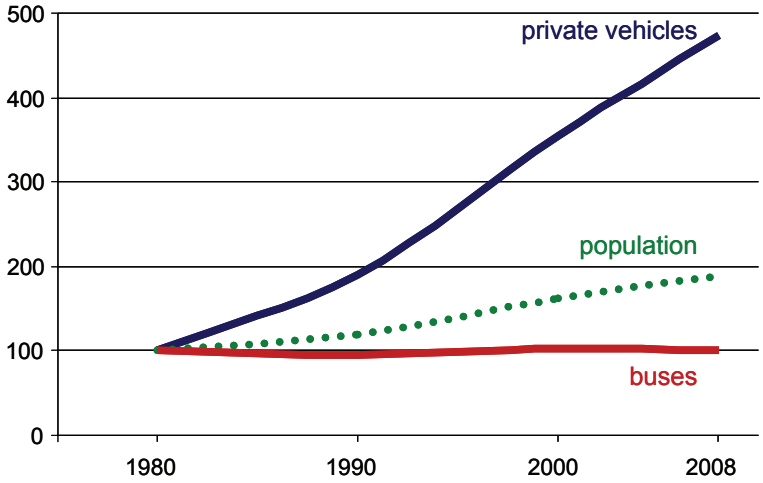
[5] Mileage – a concept that describes the distance as measured in kilometers traveled by a given vehicle or the total number of vehicles. What is more familiarly called "kilometrage."

realistically implemented primarily for social and political reasons. On the other hand, since moving people from private vehicles to public transportation is connected to relative trip costs and the level of services (the amount and quality of service), resources would have to be allocated to improve and cheapen trip costs even at the cost of heavy subsidies to those running the service.

Figure 1

Trends in public and private transportation use and population growth

1980-2008, base: 1980=100



Source: Central Bureau of Statistics, *Statistical Abstract of Israel 2009* – Table 24.15 and 24.4; *Monthly Bulletin of Statistics11/2009* – Table 1/B.

Proponents of this policy claim that giving subsidies is rational in this case taking into consideration the costs of the negative externalities that will be saved to the economy if such a move from private vehicles to public transportation were to happen. With this, it is important to note that the ability of public transportation to lessen the negative externalities of the private vehicle is subject to debate. There are those who claim that improving the level of services and their quality will bring down traffic congestion and a reduction in air pollution, while others say that because of the dominance of private vehicles versus public, primarily in terms of time traveled including convenience and availability, a significant increase in the amount of public transportation will not cause a substantial decline in traffic congestion. As such, projections and research show that an increase in the use of public transit is likely to bring about a marginal improvement in air quality (Bae, 1993).

2) **Equality**

Equality in transportation is expressed as the effort to supply more transportation alternatives to citizens whose accessibility is limited (Krumholz and Foreste, 1990). According to this approach, public transportation is seen as a merit good that the state is obligated to provide. In reality, though, in the area of transportation in Israel and the world, the rapid increase in private vehicle ownership has not been equal for all of the population. There are clear gaps between different population groups in their rate of car ownership, and they create discrimination in accessibility to sources of employment, shopping areas and services as well as residential and cultural centers. This discrimination strengthens the existing gaps in the labor market, education, health, social, and cultural activities. In addition, the rise in longevity and the aging of the population (the elderly use relatively more public transportation) points to the direction of the future trend with gaps that are expected to persist and deepen in the coming

decades. For those who are considered "transportation dependent" (those of limited ability: the elderly, those with physical disabilities, children, women, and various ethnic groups), continued availability of a means of public transportation is critical for accessibility to places of employment, study, medical care, and other needs. The numbers of those of low income who use public transit are growing over time as a result of the inelastic demand and "transportation dependence" on these services, in general, and, in particular, for bus service while those with high income have moved to private vehicles.

The subject of accessibility to places of employment has particular social importance. A study conducted in the United States (Hay, 1993) found that almost half of the trips on public transportation are trips to work or work related. Another study on accessibility of transportation for low-wage workers in Los Angeles (Pisarski, 1992) found that the number of workers who can get to work within 30 minutes on public transportation is 77 percent less than the number who can arrive at work in that time by private vehicle. The study shows that the great gap in accessibility to work place explains why more than 60 percent of households who are classified as relatively poor use private vehicles to get to work. The growing gap between those with low wages and those with high wages is not only influenced by the fact that those of high wages have more cars, but they also make more repeated use of them. In addition, the sizeable move to the suburbs harms the effectiveness of the transportation system and worsens problems of segregation.

Various papers (Pucher, 1982) look at the question of how transportation authorities and transportation planners deal with the great demand of low income earners for public transport. They claim that several factors, some of them exogenous and some of the endogenous, have contributed to inequality in the supply of public transportation services and to the lack of relation between demand and need for services of those dependent on them. On the assumption that

the majority of public transportation is concentrated in the city center as bus service, it should be expected that the majority of resources would be directed towards improving service in these areas, from an efficiency perspective as well as from considerations of equality. It can be seen, though, that it is in the area of trains that there has been a dramatic change (Pisarski, 1996). In the United States, for instance, bus services, in terms of vehicle hours, rose between the years 1983-1994 at only 10.7 percent, versus underground and overground train service that rose at a rate of 28 percent and the scope of the light rail service increased by 108 percent. This despite the fact that in 1993 buses carried a number of travelers equal to all the other means of transportation combined. This attests to the clear preference in budgeting for trains over buses. Research has also shown that the number of bus trips declines with a rise in income, whereas the use of underground trains and private vehicles increases with rising income (Pisarski, 1996).[6] Other research has found that the poor, the elderly, women, and minorities use buses (Pucher, 1981). Thus it is surprising to find that the level of subsidy for this form of transit is the lowest of all. It turns out that the subsidy for those traveling to work by train is three times higher than the subsidy for bus riders. In addition, the difference in the amount of capital investment tips the scales even lower to the detriment of bus riders.

Another measure of inequality in transportation is expressed through the cross subsidy of high income travelers by those with low income. As is typical, high income people are less sensitive to price changes than those of low income, yet in the situation of the demand for public transportation it is reversed due to the inelastic demand of those with low incomes, where the availability of alternate

[6] As of 1995, the average annual salary of a bus rider in the United States was less than $20,000, versus the average annual salary of $40,000 for the train rider and more than $5,000 for the private vehicle user (U.S. Department of Transportation, 1999).

transportation methods is relatively low. Amongst those of high income where the use of a private vehicle is an alternative, demand is elastic relative to the costs of public transportation (Cervero, 1990). Therefore, bus companies lower the tariff per kilometer in the suburbs relative to the fare per kilometer in the city center, and this creates the cross subsidy between the payment for intra-city travel and travel to the suburbs.

Research points to several reasons for this situation: first, there is public pressure to reduce traffic congestion, primarily in the arterial routes from the suburbs to the city center (Cervero, 1990); second, there is public pressure to reduce air pollution (Garret & Wachs, 1996); and the third reason points to the political arena. Large public works have always been a favorite past time of politicians and their constituents and public transportation projects are no different. Cutting the ribbon at the opening of a new train line brings media attention that is thought to be positive for the advancement of political interests. Added to this is the fact that those who are "dependent on public transportation" are not a strong group of advocates and some may not even be able to vote (immigrants and foreign workers, for example). In addition, the percent of minority voters is relatively low compared to the voters in the suburbs, and so, the tendency is to invest in projects that benefit the latter (Pucher, 1982).

2.J. Public Policy in Transportation in Israel

About a decade ago a commission was established in Israel to examine the policy regarding public transportation (State of Israel, Ministry of Transportation, 1999). This committee set itself the following goals:

1) Insuring a reasonable level of mobility at a reasonable cost to all citizens of the State according to their needs.
2) Lessening traffic congestion and the negative externalities.

3) Advancement of public transportation as a means of supporting and achieving desirable goals in the field of the economy and society.
4) Operating public transport at a highly efficient economic level, amongst other things through lowering the costs involved in providing the service.
5) Improving the ability of public transportation to contribute to the national policy of dispersing land usage in metropolitan areas and locating employment and residences.

Setting these goals by the committee expressed the State's priorities for transportation in Israel, where at the top of the list was equality of accessibility and after that lessening traffic congestion and negative externalities.

3. Indicators of Transportation Development – A Methodological Presentation

This study examines aspects of accessibility to transportation and the combination of private and public transportation on the basis of a comparison of thirteen metropolitan areas around the world, including the Tel-Aviv metropolitan areas. The comparison is based on data that was gathered in the framework of a millennium research – *Millennium Cities Database for Sustainable Transport* – that was published in 2001 by the International Association of Public Transport (UITP). The full study includes data on more than 200 indicators that were gathered on 100 metropolitan centers around the world in the course of 1995, including Tel-Aviv. (In this study the Tel-Aviv metropolitan area had a very broad classification as an area of 2.5 million people, almost half of the population of Israel at that time.) In the current study, twelve Western metropolitan areas were chosen from amongst

all of those in the millennium study – eight that represent Western European cities which are known for their well-developed public transportation systems and four additional metropolitan areas from North America (New York), Australia (Melbourne and Sydney) and New Zealand (Wellington).

In 2006, the International Association of Public Transport (UITP) published an updated study, *Mobility in the Cities Database*, that was based on data gathered in 2001 on 120 indicators of public transportation from 52 cities, mostly large European cities. This study, though, did not include cities in North America, Australia or the Middle East (Tel-Aviv amongst them) and a gap developed between the two studies relating to the data that was updated on metropolitan cities. The missing updated data for some of the cities in the sample of this study means that the two studies can not be compared. The current research makes use only of the available comparative data on the Tel-Aviv metropolitan area and other metropolitan areas in the world for 1995. With this, the development of the transportation system since 1995 has been examined in the current study through a presentation of different indicators on the countrywide level with a careful choosing of those variables that reflect similar significance (except for one piece of data – priority public transportation lanes per person – which has no significance beyond the metropolitan area level). As such, only a portion of the data that were examined for 1995 are in available data sources in Israel.

Additional updated data were taken and collected during 2009 from information sources and publications of public bodies in Israel, like the Central Bureau of Statistics and the Ministry of Transportation. Additional data were taken from websites of metropolitan public transportation companies during the months of May-August 2009. Data regarding trip costs on toll roads in Israel and the United States were gathered in the course of December 2009.

The Study's Variables

A. **Mobility of private vehicle travelers in metropolitan Tel-Aviv relative to other metropolitan areas in 1995:**

1) Supply and demand for private vehicle transport:
- Average number of trips per person
- Kilometers traveled per person (annual)
- Length of roads per 1,000 persons
- Length of roads per hectare (an area equal to 10 dunam or 10,000 square meters)
- Number of private vehicles per 1,000 persons

2) Accessibility via private vehicle
- Average speed (kilometers per hour)
- Number of parking places in the city center per 1,000 employee positions

B. **Development in private vehicle ownership in Israel – 1995-2006:**

- Total mileage for private vehicles (in millions of kilometers)
- Mileage for private vehicle per person (in kilometers)
- Total length of roads in Israel (in kilometers)
- Total area of roads in Israel (in 1,000 square meters)
- Number of private vehicles per 1,000 persons
- Percent of households with at least one private vehicle
- Percent of households with two or more private vehicles
- Monthly expenditure for private vehicle (2006 data)

C. **Developments in the area of all motorized vehicles in Israel – 1995-2006**

- Overall position of motorized vehicles
- Mileage for all motorized vehicles per annum
- Total length of roads in Israel (in kilometers)
- Total area of roads in Israel (in 1,000 square meters)

D. **Comparison of developments in the area of private vehicles – Israel and other countries:**

- Rate of change in length of roads (kilometers), 1995-2006
- Rate of change in number of vehicles per 1,000 persons, 1995-2006
- Trip cost on toll roads (dollar/mile), 2009

E. **Mobility of travelers on public transportation in the Tel-Aviv metropolitan area relative to other metropolitan areas in 1995:**

1) Supply and demand for public transportation travel:

- Number of average daily trips per person
- Percent kilometers traveled on public transportation out of all motorized kilometers traveled
- Total number of public transportation vehicles per million persons
- Kilometers of public transportation service per person per annum
- Kilometers of public transportation service per hectare per annum
- Kilometer per passenger seat per person

2) Mobility on public transportation

- Variety of modes of public transportation available to residents
- Average speed (kilometers per hour)
- Length of public transportation priority lanes: meters per person and meters per hectare

F. **Development of public transportation in Israel – 1995-2006:**

- Number of buses per 1,000 persons
- Mileage for buses per person per annum (in kilometers)
- Total number of passenger seats on public transportation per 1,000 persons
- Number of taxis per 1,000 persons

- Mileage for taxi per person per annum (in kilometers)
- Number of travelers by train per annum
- Public transportation priority lanes per 1,000 persons (in meters, for Tel-Aviv metropolitan area)
- Family expenditure for public transportation (2006 data)

G. **Comparison of developments in public transportation – Israel and other countries:**

- Rate of change in the number of public transportation vehicles per million persons (1995-2004)
- Rate of change in the number of travelers by train (1995-2004)

H. **Integration of transportation services and costs of public transportation (current data for 2009):**

- Level of integration between modes of transportation/operators
- Relative travel costs in dollars and ticket validity time (cost of a single ticket, single ticket validity time, cost of a day pass, cost of a weekly pass, cost of a monthly pass)

4. Transportation Development – Tel-Aviv and Metropolitan Cities in the West

Characteristics of transportation in metropolitan areas in the West are presented in the tables that follow including data on the central metropolitan cities that are included in this study – Amsterdam, Berlin, Copenhagen, London, Melbourne, New York, Oslo, Paris, Rome, Stockholm, Sydney, Wellington, and Tel-Aviv. The cities vary in the size of their population and in the density levels of their population, with the metropolitan area of Tel-Aviv standing out for being the most densely populated of the metropolitan areas examined (see Table 1 – Population density per square area unit). Nevertheless, the variety of transportation methods available to Tel-Aviv residents is amongst the least relative to the other areas examined.

The division between private vehicles and development of public transportation indicates the relatively good position of mobility for private vehicles in the Tel-Aviv metropolitan area in 1995. Table 2 compares Tel-Aviv to the other metropolitan areas in the sample (average) for the base year 1995.

The indicators that are presented that show development over time widen the comparison for Israel and complete the picture by showing the values ten years later (Table 3). The most striking finding is that the growth in mileage including private vehicles in Israel came to some 44.8 percent between 1995 and 2006 and was much greater than the increase in overall road length in kilometers (21.9 percent) in the same time period. Therefore, congestion on Israeli roads rose during those years.

In addition to this there was a tremendous growth in the number of private vehicles in Israel – a rate that surpasses the average in the other countries in the sample (see Table 4). The increase is expressed in a rise in the rate of households that own at least one private vehicle,

and even more, in those households with two or more private vehicles, 60 percent in one decade (Table 3). This change in the number of motorized vehicles in Israel was higher compared to the countries in the sample, while the change in the length of roads was less than the average for the other countries. From this it can be concluded that the level of mobility for motorized transit in Israel decreased relative to the other countries in the sample during these years.

Table 1. **Population characteristics and transportation in different metropolitan areas of the world, 1995**

	Population	Population density (residents per hectare)	Available modes of public transport					
			Bus	Electric vehicles	Taxis	Light rail	Under-ground	Train
Amsterdam	831.5	57.0	x	x	x	x	x	x
Berlin	3,471.4	56.0	x	x	x		x	x
Copenhagen	1,739.4	28.5	x		x			x
London	7,007.1	59.1	x		x	x	x	x
Melbourne	3,138.1	13.7	x		x			x
New York	19,227.4	18.0	x		x	x	x	x
Oslo	917.8	23.0	x	x	x		x	x
Paris	11,054.3	47.6	x		x	x	x	x
Rome	2,654.2	55.8	x	x	x	x	x	x
Stockholm	1,725.8	29.0	x		x	x	x	x
Sydney	3,741.3	18.9	x		x			x
Wellington	366.4	22.0	x		x			x
Tel-Aviv	2,458.2	72.3	x		x			x

Source: *Millennium Cities Database for Sustainable Transport, 1995*.

Table 2. **Transportation by private vehicle, Tel-Aviv and other cities,* 1995**

Characteristic	**Tel-Aviv**	**Mean of other cities** (excluding Tel-Aviv)
Average number of trips per person	1.3	1.9
Kilometers traveled per person (annual)	3,259.0	5,460.0
Length of roads per 1,000 persons	2,453.0	4,546.0
Length of roads per hectare	177.0	129.4
Private vehicles per 1,000 persons	239.2	432.8
Average speed (kilometers per hour)	34.0	37.5
Number of shops in the city center per 1,000 employee positions	465.4	274.0

* The average is calculated for all cities excluding Tel-Aviv (see Table 1).

Source: *Millennium Cities Database for Sustainable Transport, 1995.*

Table 3. **Transportation development in Israel, 1995-2006 – Private vehicles**

	1995	**2006**	**Rate of change** (%)
Total mileage – private vehicle (million kilometers)	18,682	27,062	44.8
Private vehicle mileage per person (kilometer)	3,328	3,803	14.3
Total length of roads (kilometer)	14,591	17,790	21.9
Area of roads (thousands of meters)	102,542	140,483	37.0
Number of private vehicles per 1,000 persons	198	237	19.7
Percent of households with at least 1 private vehicle (%)	53	60	13.2
Percent of households with 2 or more private vehicles (%)	10	16	60.0

Source: Central Bureau of Statistics, *Statistilite 79 – Transportation 1995-2006*. http://www.cbs.gov.il/www/statistical/trans_heb08.pdf, viewed 24 August 2009.

Table 4. **Development of mobility in motorized vehicles, Israel and sample countries, 1995-2006** (percent of change)

	Israel	Countries in sample	
		Average change	Standard deviation
Change in length of roads in kilometers	22%	23%	0.20
Change in number of vehicles per 1,000 persons	18%	13%*	0.06

*Not including Australia.

Source: OECD Facebook 2008: Economic, Environmental and Social Statistics: http://www.oecd.org/LongAbstract/0.3425.en_2649_201185_40419394_1_1_1_1,00.html, viewed 7 December 2009.

4.A. Private Vehicles – Findings from the Millennium Research (Tel-Aviv Relative to Other Metropolitan Areas)

Central findings:

1) **Demand for trips**

A. Number of trips per person is relatively little compared to the overall average.

B. Kilometers traveled per person by private vehicle is low relative to the overall average.

2) **Infrastructure**

A. Length of roads per 1,000 persons is low relative to the overall average.

B. Length of roads per hectare is high relative to the overall average. With this, it is important to remember that the Tel-Aviv metropolitan area density is higher relative to other metropolitan areas that were checked (see Table 1).

3) **Mobility**

A. Average speed of travel is slightly lower compared to the overall average, despite the lower demand relative to trips. It seems that this is due to the relatively high density in the metropolitan Tel-Aviv area.
B. The number of private vehicles per 1,000 persons is lower in Israel compared to the overall average.
C. The number of parking places in the city center per 1,000 employee position is high relative to the overall average.

4.B. The Development of Transportation in Israel – Private Vehicles, 1995-2006

1) Private vehicle miles in Israel were higher in the period by 45 percent (Table 3). This rate is higher than the rate of population increase.[7] Due to this, the annual average mileage per person in a private vehicle rose by 14 percent.
2) The number of private vehicles per 1,000 persons rose in the course of the period by 20 percent.[8]
3) The percent of households with at least one private vehicle grew by a rate of 13 percent in the same time period.
4) The percent of households with two or more private vehicles grew at a rate of 60 percent in the time period.
5) In 2006 households in Israel spent on average NIS 1,850 per month on transportation, some 16 percent of total consumer spending. The average expenditure on a private vehicle was NIS 1,313, which represents 71 percent of the total family expenditure on transportation.

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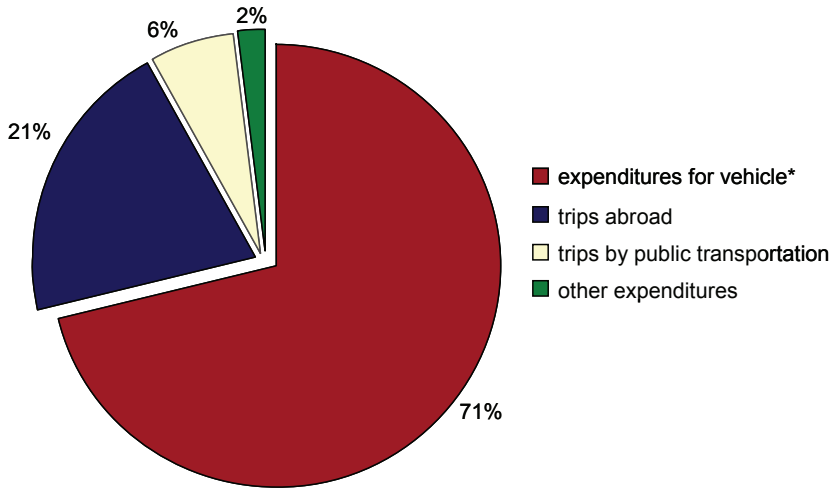
[7] Central Bureau of Statistics data show that the population grew by 27 percent (CBS, Annual Statistical Abstract of Israel 2008 – Table 2.7). www.cbs.gov.il/shnaton59/st02_07x.pdf, viewed 24 August 2009.

[8] This number is still statistically low relative to the world.

Figure 2

Household expenditure on public transportation per month

by item, 2006 (percent)



* Car registration fees, insurance, gas, etc.

Source: Central Bureau of Statistics, *Statistilite 79 – Transportation 1995-2006*, http://www.cbs.gov.il/www.statistical/trans_heb08.pdf, viewed 24 August 2009.

4.C. *Transportation Development in the Area of Motorized Vehicles in Israel, 1995-2006*

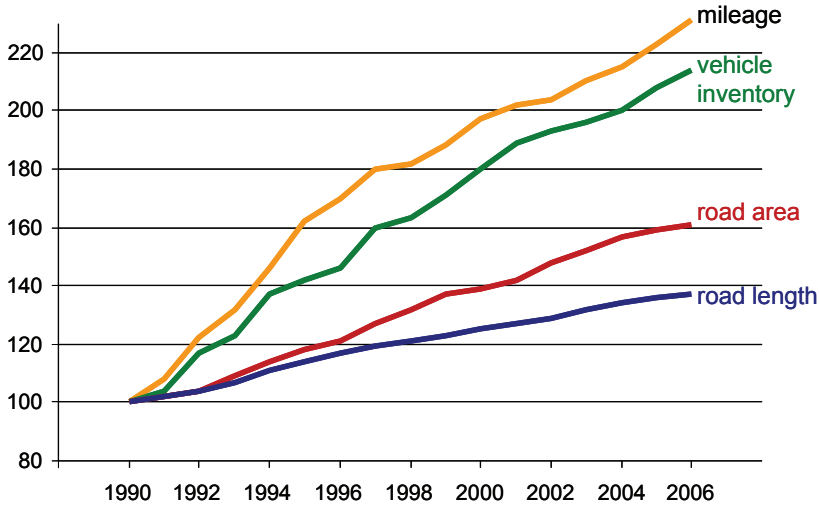
1) Length of roads in Israel rose by a rate of 22 percent (Table 3).
2) Road area rose by a rate of 37 percent.
3) Inventory of motorized vehicles rose by a rate of 50 percent.
4) Mileage of motorized vehicles rose by a rate of 42 percent.

Figure 3 describes the overall development in the area of transportation between 1990 and 2006, as it is expressed in road area and length, in vehicle inventory, and annual mileage. The data show that road density continues to grow as a result of the rapid rise in annual mileage and vehicle inventory that increased significantly more than the rise in road length and area. It should be noted that the increase in motorized vehicle mileage was caused mainly by the sharp growth of 45 percent in private vehicle mileage in the period under consideration (see Table 3).

Figure 3

Area and length of roads, inventory of cars and annual mileage

1990-2006, base: 1990=100



Source: Central Bureau of Statistics, Mileage Study 2006, http://www1.cbs.gov.il/publications/nesua06/pdf/h_intro_mavo1.pdf, viewed 31 August 2009.

4.D. International Comparison – Mobility Development in Motorized Vehicles, 1995-2006

A comparison of the number of vehicles per 1,000 persons in Israel and the other countries in the sample shows that, in Israel, there was a rise of 18 percent in the number of vehicles and 22 percent in road length (kilometers). In contrast, in the other countries in the sample, there was a rise of 13 percent on average in the number of vehicles and an average rise in road length of 23 percent.

1) **Use of toll roads**

In Israel there has been a toll road (Route 6) since 2002. The improvement in accessibility for private vehicle users who use Route 6 means they have to pay for the road use. Table 5 shows a comparison of road tolls on Route 6 versus five main toll roads in the United States (in Florida, Ohio, New York, New Jersey and Pennsylvania). The data show the median value of road tolls for private vehicles in relation to the number of travel segments for an occasional user and for a subscriber.

Table 5 shows that the cost of travel on Route 6, and particular travel over shorter segments, is significantly more expensive than toll roads in the United States. If the prices were adjusted for income, the differences would be even greater. A calculation of the coefficient of variation shows that the coefficient value on Route 6 for a subscriber and occasional user is 0.87 and 0.82, respectively. That is in contrast to a coefficient value for toll roads in the United States for subscribers and occasional users of 0.53 and 0.49, respectively. The conclusion from this is that price differences for travel on Route 6 for different trip segments are significantly higher than prices for segments of toll roads in the United States.

Table 5. **Trip prices on toll roads – median (dollar/mile)**

	Route 6		United States	
	Occasional user	**Subscriber**	**Occasional user**	**Subscriber**
1 road segment	0.50	0.32	0.10	0.09
2 road segments	0.26	0.16	0.08	0.06
3 road segments	0.21	0.13	0.07	0.06
4 road segments	0.27	0.18	0.07	0.06
Total road	0.13	0.10	0.07	0.05

Source: Internet site of the relevant toll roads authorities, viewed 6 December 2009 (details in References).

2) **Public transportation use**

Various measures for the development of public transportation in Tel-Aviv and other cities in the sample are presented in the following tables. Table 6 shows data on different characteristics of public transportation in the Tel-Aviv metropolitan area in 1995 compared to the overall average for the other cities in the sample. In Table 7 it can seen that the measure of integration between public transportation operators in Israel is lower relative to other countries in the sample. The price of bus travel is cheaper relative to other places examined, but the ticket is only valid for a short time compared to most other places checked. Regarding the amount of bus and taxi service, Table 8 shows that the amount of bus service per person has declined in the years 1995-2006 while the amount of taxi service has risen by nearly 50 percent. The amount of travel by train rose during the same period by hundreds of percents. In the period between 1995 and 2004, the number of public transportation vehicles to million persons in the sample countries increased by five percent, while the numbers in Israel declined by 12 percent. In parallel, the change in the number of passengers by train in Israel rose very rapidly relative to other cities in the sample.

Table 6. **Public transportation, Tel-Aviv and other cities,* 1995**

Characteristic	**Tel-Aviv**	**Average of other cities** (excluding Tel-Aviv)
Number of average daily trips per person	0.28	0.45
Percent kilometers traveled by public transportation of all motorized kilometers traveled	20.40	18.40
Total public transportation vehicles per million persons	1,168.40	1,346.70
Kilometers of public transportation service per person	49.70	86.10
Kilometers of public transportation service per hectare	5,591.00	3,331.20
Kilometer passenger seats per person	2,477.00	4,980.60
Average speed (kilometer per hour)	17.00	29.60
Public transportation priority lanes: meters per 1,000 persons	14.70	243.90
Public transportation priority lanes: meters per hectare	1.00	7.80

* For cities included in the average see Table 1.

Source: *Millennium Cities Database for Sustainable Transport, 1995.*

Table 7. **Public transportation in the cities – updated data from internet sites around the world**

	Integration level between transport-tation modes/ operators	**Price of a single ticket** (dollars)	**Single ticket validity time**	**Price of a day ticket** (dollars)	**Price of a weekly ticket** (dollars)	**Price of a monthly ticket** (dollars)
Amsterdam	full	3.7-7.1	hour	9.9	17.2-42.5	56.8-138.6
Berlin	full	1.8-3.0	two hours	8.6-9.2	37.2-45.8	72.4-89.5*
Copenhagen	full	4.0-6.0	hour	22.9-34.3	39.1-47.7	61.0-101.0
London	full	6.9	not available	12.0-21.0	43.1-73.5	165.6-282.3
Melbourne	full	3.1-4.8	two hours	4.0-8.9	16.9-41.6	92.0-141.8
New York	full	2.2-5.0	two hours	8.2	27-45	89
Oslo	full	4.1-5.9	hour	10.6	32.7	90.1
Paris	full	2.2-2.4	1½ hours	8.3-18.7	24.4-47.4	80.3-156.0
Rome	full	1.4	1¼ hour	5.6	22.7	42.5
Stockholm	full	2.1-4.2	hour	14.0	36.2	96.2
Sydney	full	1.6-5.1	not available	10.6-14.2	28.5-50.3	none***
Wellington	almost full**	0.7-4.7	for immediate use on another line in the same travel direction	3.7-8.7	not available	66.7-121.3
Tel-Aviv	little****	1.4-2.3	one time use*****	3.2	not available	51.9-84.0

* Only for trips originating after 10:00.
** Between most bus and suburban train operators.
*** There is a quarterly or yearly pass.
**** Between only two bus operators with a day/monthly pass.
***** There are a limited number of transfer passes that can be used on internal service lines.

Source: Internet sites of operators (details in References and notes to Appendix 1).

Table 8. **Trends in public transportation in Israel, 1995-2000**

	1995	2006
Number of buses per 1,000 persons	1.9	1.8
Annual mileage on buses per person (kilometers)	143.0	122.0
Total number of bus passenger seats per 1,000 persons	47.0	37.0
Number of taxis per 1,000 persons	1.7	2.5
Annual mileage in taxis per person (kilometers)	152.0	213.0
Number of annual passengers on the trains (1,000)	4,845.0	28,351.0
Length of public transportation priority lanes per 1,000 persons (in meters, Tel-Aviv metropolitan area)	14.6 *	24.9

* Source for this data: *Millennium Database*.

Source: *Millennium Cities Database for Sustainable Transport, 1995*, and selected tables on the subject of transportation (Sources) from the CBS website (www.cbs.gov.il).

Table 9. **Public transportation trends in Israel and the world, 1995-2004**

	Israel	Countries sampled	
		Average change (%)	Standard deviation
Change in the number of public transportation vehicles per million persons*	-12%	5%	0.11
Change in the number of train passengers **	274%	24%	0.16

* Countries included in the table: Great Britain, Denmark, France, Germany, Holland, Italy, Norway, Sweden, United States.

** Countries included in the table: Denmark, France, Germany, Sweden, United States.

Source: United Nations Databasehttp://w3.unece.org/pxweb/DATABASE/; STAT/40-TRTRANS/02-TRRoadFleet/020-TRRoadFleet.asp, viewed 9 December 2009.

4.E. Public Transportation Development: Findings of the Millennium Research (Tel-Aviv Metropolitan Area Relative to Other Metropolitan Areas Examined)

1) **Supply and demand for public transportation services**

A. The average number of daily trips per person on public transportation is low compared to the overall average.
B. The relative use of public transportation out of all modes of transportation, as measured by the percent traveled on public transportation out of all motorized transportation, is higher than the overall average.
C. The number of public transportation vehicles per million persons is low relative to the overall average.
D. Kilometers of public transportation service per person are low relative to the overall average.
E. Kilometers of public transportation service per hectare are high compared to the overall average, apparently as a result of the relative high density in metropolitan Tel-Aviv.
F. Kilometer of passenger seats per person is low in Israel relative to the overall average.

2) **Level of mobility on public transportation**

A. The average speed of a public transportation trip is very much lower compared to other places examined, apparently as a result of the relative density of metropolitan Tel-Aviv and the lack of priority lanes for public transportation in the metropolitan area.
B. The length of public transportation priority lanes per person and per hectare is significantly lower relative to the other places examined.

3) **Development of public transportation in Israel, 1995-2006 – characteristics of supply and demand**

A. The variety of modes of public transportation has not grown and includes only buses, taxis and trains.[9]
B. The number of buses per 1,000 persons is lower by a rate of 5 percent.
C. The annual bus mileage per person by kilometer declined by a rate of 8 percent.
D. The total number of passenger seats on public transportation (bus) per 1,000 persons declined by a rate of 19 percent.
E. The number of taxis per 1,000 persons rose by a rate of 47 percent.
F. The annual taxi mileage in kilometers per person increased by a rate of 40 percent
G. The number of train passengers rose by a rate of 485 percent.[10]

4) **Quality and cost characteristics**

A. The length of public transportation priority lanes per 1,000 persons (in meters, metropolitan Tel-Aviv) rose by a rate of 70 percent.[11]
B. Integration between transportation modes and between operators is almost non-existent.
C. The ticket validity time is short relative to most other places examined.
D. The average family expenditure for public transportation is a total of 6 percent of all transportation expenditure.
E. Cost of bus travel is inexpensive relative to other places checked.

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[9] In Haifa there is also travel on the "*Carmelit*" – an underground funicular railway.

[10] There is no data for train mileage for 1995; the train mileage in 2000 was 3,812 (in thousand kilometers) and in 2005 mileage went up to 8,238 (in thousand kilometers) (from the CBS, 2009, Table 2/17).

[11] Despite the high rise in this rate, this is still significantly low relative to other countries examined.

5) **International comparison 1995-2004: public transportation**

A. The number of public transportation vehicles per million persons is low in Israel by a rate of 12 percent, while in the sample countries the rate rose by an average of 5 percent.
B. The number of train passengers rose in Israel at a rate of 274 percent relative to an average rise of 24 percent in the sampled countries.

5. Discussion: Accessibility to Transportation in Israel

In every discussion on measures of accessibility to transportation in Israel it is important to distinguish between the level of accessibility for those using private vehicles and those using public transportation. The distinction is important for three main reasons:

1) In general there is a relation of interchangeability between mobility in a private vehicle and mobility using public transportation.
2) Overuse of private vehicle transport influences the level of economic efficiency (primarily negative externalities, stemming from increased use of private vehicles).
3) The relationship between mobility in a private vehicle and mobility in public transportation influences the level of inequality. Since public transportation is needed primarily by those who are termed "transportation dependent" (low-income earners, students, the elderly, people with disabilities, etc.), as public transportation accessibility improves relative to mobility of private vehicles, this will contribute to narrowing inequalities.

An examination of private vehicle transportation in the Tel-Aviv metropolitan area in 1995 indicates that the public who use private vehicles were in a good situation relative to those in other metropolitan areas examined. The demand for private vehicle transport, according to number of trips per person and by kilometers per person, was low compared to other places. Although the supply of roads per person was lower relatively speaking, the supply of roads compared to metropolitan areas was relatively high. The average speed of travel in metropolitan Tel-Aviv, the most crowded of the areas examined in the framework of this study, is only slightly lower than the average. From the perspective of parking arrangements in the main business center, the number of parking places per 1,000 employee positions is significantly higher in Tel-Aviv than the overall average. The total of the indicators leads to the impression that the level of mobility in metropolitan Tel-Aviv in 1995 was of a relatively reasonable level.

Regarding the change in mobility in public transportation in Israel in the years 1995 to 2006, it turns out that the density on Israel's roads increased following the relatively rapid annual growth in the inventory of motorized vehicles and the annual mileage. The main part of the growth was in the private vehicle domain with only moderate relative growth in the area and length of roads. The annual mileage in private vehicles rose during the period at a significantly higher rate than the increase in population, and there was a similar growth in private mileage per person. The increase in private mileage was caused for the most part by an increase in the average number of vehicles per 1,000 persons, which amongst other things, was the result of a rise in the percent of households with at least one private vehicle, as well as the percent of households with at least two private vehicles. The increasing density, primarily on urban roads where there was a relatively low rate of increase in area and length of roads, worsened the situation that results from traffic congestion and harmed the

mobility of travelers, mainly those using private vehicles. Operating Route 6 undoubtedly improved accessibility of private vehicle users. Nevertheless, a comparison of road tolls along this route versus toll roads in the United States indicates the significantly high price for use of the road relative to other toll roads – especially for short segments.

Regarding public transportation in the Tel-Aviv metropolitan area in 1995, the examination indicates its inferiority for its users relative to those in other metropolitan areas. The demand for public transportation from the perspective of number of average daily trips per person is low relative to the other cities examined. At the same time, the supply of public transportation per person, from the point of view of the number of vehicles, the number of vehicle kilometers and the number of kilometer passenger seats is also low relative to the world. The combination of low supply, the limited variety of public transportation options, the relative density of metropolitan Tel-Aviv and the lack of priority lanes for public transportation has caused the mobility on public transportation as measured by speed of journey during the average time of the trip, to be significantly lower than the average in the rest of the places checked in this study.

In the course of 1995-2006, there was a change in the internal division between modes of public transport in Israel: train mileage increased during the period at a significantly higher rate than the increase in population. As a result of this, the number of train passengers jumped almost six-fold between 1995 and 2006. This change in train usage in Israel stands out as an exception amongst the countries examined (see Table 9). Regarding taxis, it turns out that taxi mileage per person in 1995-2006 rose by a rate of 40 percent, and this is due to the significant rise in the number of taxis per person in Israel. Nevertheless, despite the rise in demand for the two modes of transport, demand for public transportation by bus per person declined during the period in terms of number of buses, mileage and in terms of passenger seats for the population. This stems from a relative fixed

demand for buses compared to the increase in population during this period.

The price of bus travel in Israel is low compared to other countries. For this reason the expenditure on public transportation is a very small part (6 percent) of average overall family expenditure on transportation, and an even smaller part (1 percent) of the overall family consumer expenditure. On the one hand, it is possible to say that bus travel is affordable. On the other hand, the almost complete lack of integration of services and operators in Israel, and short ticket validity time reduce the value of bus use. These findings can explain the lessening of the market share of bus service in the public transportation system, in particular, and in the transportation services, in general. Nevertheless, buses are still the major public transport vehicle in Israel, carrying close to 100 million travelers a year (Shiftan & Sharabi, 2006).

The examination in the study of the government of Israel's declared goals shows that the main objectives for transportation are to insure a suitable level of mobility at a reasonable price to all citizens of the State according to their needs (equality in transportation), and to lessen the traffic congestion and its negative externalities. These goals arise from the published conclusions of various committees on transportation (The Committee to Examine Public Transportation in Israel, 1999; The Committee to Examine and Propose Recommendations Regarding Opening Public Transportation to Competition, 1996; The Report of the Inter-Ministerial Team to Examine Public Transportation in Israel, 1991). The changes in the transportation system that began in the decade of 1995-2006, which were discussed in this paper, raise doubts if the transportation system in Israel is working in the right and desirable direction from the point of the view of the Israeli marketplace as well as with regard to the suitability of the public transportation system to attain the central goals as designated:

The first goal is **to insure a suitable level of mobility at a reasonable price to all of the citizens of the State according to their needs (to attain mobility equality)**. There is no question that a public transportation system that supplies a suitable level of services to residents is a necessary condition for reducing socioeconomic inequality. In practice, if the compatibility of the public transportation system to this goal is examined, it has been shown that the public bus system which is the major mode of transportation for the weaker segments of the population who are "transportation dependent" are, in fact, relatively inexpensive although they are not an integrated service nor are they are they characterized by a particularly high level of service. The rise in train service over this period does not contribute greatly to the issue of equality. This population is not the main user of the train service since they are primarily located within the urban areas where trains are not a relevant option. Also, the rise in taxi services does not contribute to the issue of equality since, without a doubt, it is an expensive public transportation option for those of limited means. In this situation the mobility of the group is harmed along with the ability to narrow social gaps.

The second goal is to **decrease congestion and its negative externalities**. Indeed the level of mobility in private vehicles in Israel was significantly reduced between 1995 and 2006 due to rising traffic congestion. In this situation it would have been possible to create incentives to move travelers from private vehicles to public transportation. Nevertheless, a move of passengers such as this, especially for those whose time is very valuable, is not simple and its success is reliant on the ability to reduce the time differences in travel. Unfortunately, the private vehicle still has significant advantages over public travel in this area. From this perspective an integrated policy approach is required that from one side increases traveler mobility on public transportation, through improving the level of service (the amount and quality of services) and giving priority on the roads, and

on the other side lessens the attractiveness of private vehicle transportation by making its use more expensive. The study indicates that the time required to make a trip in metropolitan Tel-Aviv using public transportation in 1995 was significantly greater than in a private vehicle. While the data on supply of transportation in 2006 indicate a decrease in private vehicle mobility due to a rise in traffic congestion, on the other hand it does not indicate a narrowing of gaps relative to travel on public transportation and/or an improvement in the ability of public transportation to represent a quality alternative to private transport. The variety of transportation modes that exist, the lack of integration between them and their operators, and the low level of service offered by buses has not created suitable incentives to move travelers of higher socioeconomic status to public transportation. The rise in train mileage and the number of travelers on it, who are generally from the relatively established socioeconomic segment, should be seen as a positive development and one to be encouraged. With this, it should be recalled, though, that the train service is primarily inter-city and problems of traffic congestion on the inter-city roads and the negative externalities that comes along with it are less relative to congested urban areas. As opposed to the train the main growth in taxi travel was concentrated in congested urban areas. Taxis do not represent a suitable means of transportation for large numbers of people and so the rise in supply of taxis does not contribute in a significant way to reducing traffic congestion and its negative externalities. Not only did the government not succeed in creating "pull" factors towards public transportation, it also did not succeed in creating "push" factors from private vehicles to public transportation use. Policy measures that reduce the value of using private vehicles, like increasing taxation on use and ownership of a private vehicle, congestion tolls, etc. were not used apparently in the necessary amounts.

In the last few years it is becoming apparent that certain changes in transportation services are necessary and among them:

A. **A combined pass**. The introduction of the combined "multi-line" pass is meant to improve the amount of integration between transportation means and operators.
B. **Rapid transit systems.** The public transportation systems in Israel are due in the near future to include rapid bus transit (RBT) as well as light rail systems. Two major projects in the Tel-Aviv and Jerusalem metropolitan areas are also in the planning and relatively advanced stages of execution.
C. **Priority lane policy.** There has been an increase in priority lanes for public transportation.
D. **Taxation policy.** The number of bodies that support a change in taxation policy from support of the private vehicle to public transportation is growing.
E. **Competition in public transportation.** Competition in the supply of bus services through competitive tenders, and breaking the monopolies of "Egged" and "Dan" who have dominated the bus marketplace since the establishment of the country, should be considered. Research shows that this type of competition improves the level of service, brings down the price of travel and even succeeds in increasing the number of passengers (Ida, 2008).

There is no doubt that these steps are in the right direction. The main problems are in inadequate implementation of policy and the pressure of special interest groups. As a result of this, projects like the light rail in Jerusalem and Tel-Aviv have been delayed for years. Reform in the form of taxation on private vehicles, which has been suggested by the Ministry of Finance, was not properly implemented and the competition in the bus service was also not implemented according to the original plan's time frame.

6. Summary and Recommendations

This study points to some central findings in the area of transportation in Israel: first, it is clear that in the period 1995 to 2006, the level of mobility and accessibility of residents of the State of Israel was damaged. This development was primarily due to a rise in the use of private vehicles while the best solution to this problem is advancing the use of public transportation at the expense of private transportation. Secondly, the study shows that gaps in mobility between travelers using private vehicles and public transportation have not narrowed and this development goes against the declared policy of the State.

On the basis of a lack of fit between the declared policy and the reality, the following recommendations are made:

A. The establishment of metropolitan transportation authorities or regions that will give an answer to the transportation needs of area residents. Transportation is administered today on the national level and this prevents more efficient management of the transportation system. This conclusion has also been reached by the various public transportation reform committees (State of Israel, Ministry of Finance and Ministry of Transportation, 2007).
B. Improvement and/or increasing the variety of public transportation modes.
C. Improvement in the level of integration between transportation modes and operators.
D. Creating competition between public transportation operators concentrating the competition on variables like the level of service (and not variables like reducing subsidies) in order to create incentives for operators to supply high level service (Ida, 2008).

E. Improving the level of service to public transportation passengers: frequency, ease of travel, location of stations, accessibility for people with disabilities, customer information service, and the like.
F. Efficient planning of the public transportation network and suiting it to the consumer's needs with an emphasis on giving an answer to special needs. This is critical in order to attract travelers from their private vehicles to public transportation. It is recommended to concentrate on finding ways to shorten the time of the journey from door-to-door where the private vehicle has a significant advantage over public transport (Ida, 2008).
G. Increasing the number of public transportation priority lanes and scrupulous enforcement of their right of way.
H. Changes in the taxation policy that give preference to private vehicle users (leasing vehicles, payments for vehicle ownership, designated free parking spaces, and the like), and the creation of a taxation mechanism that encourages public transportation usage.
I. Instituting a congestion toll on lanes entering the city and its center.
J. Limiting parking areas and increasing parking prices.
K. A re-evaluation of the tolls on Route 6 and a reorganization of the tariff calculation on it. It is advisable primarily to examine the possibility of canceling the minimum payment for three segments even when fewer segments are used.

It can be hoped that implementation of a policy that combines these policy steps with wisdom and the required proportionality will bring about an improvement in the transportation system in Israel, in general, and an improvement in measures of mobility and accessibility for all of the State's residents. Actions such as these could help achieve the social and economic goals that were set by the government in this area.

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Appendix 1. **Notes to the data on Table 7**

- The data were collected from April to August 2009 from the internet sites of the public transportation operators in the different cities. In some of the cities there was a change in the travel price during the month that was examined. The prices that appear in the table are the more updated ones.
- The comparison between data is more complicated since every city has a unique price structure. The data in the table make the best possible comparison between similar activities.
- For ease of comparison, the price of the trip in the local currency was changed into US dollars, at the exchange rate effective on 10 August 2009.
- Full integration means: underground or overground train, electric train (tram) and/or light rail and bus, with a combining of different operators (including private) in an integrated travel service. In some of the cities the public transportation service included other special transportation modes, like ferries, canal boats, monorail, etc.
- In the majority of the cities the price of a trip is taken from the distance (as expressed in areas, rings, etc.) traveled from beginning to end of trip. There are places where there is importance to the hour of travel (in London during rush hours, the prices are higher) or the day of travel (Melbourne, for instance, offers reduced rate travel on weekends).
- In some of the places there is a difference in price for the way the ticket is purchased and not the distance: a single travel ticket purchased ahead of time at an automated machine or the ticket window will be less expensive than one purchased in cash from the driver (Paris, Oslo, Stockholm). In some places (Paris) a ticket

purchased from the driver is non-transferable to other modes of transport (transfer ticket).

- The range of prices in most of the cities goes from a minimum to a maximum and sometimes there are a number of in between prices that do not appear on the chart. In general, the lowest price is the price for a basic trip in the city center and the highest price includes going out to the outermost suburbs of the metropolitan area.
- There are some cities where the ticket for travel on the "ring road" (around the main business center) is at no additional charge (Melbourne) or at an especially low price (Wellington, Berlin).
- There are places where there is a difference in price for travel on an express bus line (New York).
- In some of the cities a weekly pass is for set days (like, Paris where the ticket can be used Monday to Sunday only) while in some of the cities it can be used for a total of seven days from the first day that it is used (Sydney). Likewise regarding a monthly ticket, in some of the cities the ticket is for a calendar month while in others, the month begins with the first use (Copenhagen).
- In almost all of the cities, paying in advance for a number of trips reduces the ticket price for each trip significantly (multi-travel ticket in Israel, "carne" in Paris, coupons in Stockholm). These reduced price tickets do not appear in the chart.
- All cities have a system of discounts for those who are entitled: the elderly, those with disabilities, children and youth, the needy. These prices do not appear in the chart.
- In some of the places there are family or group tickets, which are primarily for tourist or business people visiting a city for a number of days. Some of these tickets include discounts at tourist attractions in the city.

Appendix 2. **Characteristics of travel in private vehicles – Tel-Aviv and other metropolitan cities, 1995**

	Average number of trips per person	Average distance per trip (kilo-meters)	Kilo-meters traveled per person per annum	Road length per 1,000 persons	Road length per hectare	Private vehicles per 1,000 persons	Average speed (kilo-meters per hour)	Number of parking places in the city center per 1,000 employee positions
Amsterdam	1.2	12.7	3,909	2,597	148	322.6	33	315.6
Berlin	1.4	8.9	3,071	1,495	84	354.5	31	174.2
Copenhagen	1.6	14.9	4,672	4,574	130	275.3	50	220.7
London	1.4	11.3	4,114	1,919	113	332.0	29	122.2
Melbourne	2.7	8.7	7,648	9,534	130	593.7	43	348.4
New York	2.5	14.1	8,107	4,878	88	444.0	39	65.6
Oslo	2.2	9.8	6,410	6,100	146	383.7	35	164.4
Paris	1.2	11.3	3,935	1,927	92	418.0	36	141.6
Rome	1.5	13.2	5,201	4,135	230	655.3	29	344.5
Stockholm	1.3	18.7	5,041	4,496	130	386.0	42	136.9
Sydney	2.9	10.6	6,945	6,890	130	515.6	36	196.6
Wellington	3.0	8.3	6,470	6,004	132	513.1	47	1,057.3
Tel-Aviv	1.3	11.5	3,259	2,453	177	239.2	34	465.4
Average for all cities excluding Tel-Aviv	1.9	11.9	5,460	4,546	129	432.8	37.5	274.0

Source: *Millennium Cities Database for Sustainable Transport, 1995*.

Appendix 3. **Characteristics of public transportation – Tel-Aviv and other metropolitan cities, 1995**

	Average number of daily trips per person	Percent kilo-meters traveled on public transport	Total public transport vehicles per million persons	Kilo-meters of public transport service per person	Kilo-meters of public transport service per hectare	Kilo-meter passenger seat per person	Average speed (kilo-meters per hour)	Length of public transport priority lanes: meters per person	Length of public transport priority lanes: meter per hectare
Amsterdam	0.66	16.9	892.4	57.6	3,286	3,221	19	85.4	5
Berlin	0.72	28.3	1,432.4	115.3	6,455	5,905	27	140.2	8
Copenhagen	0.46	17.5	1,052.6	104.4	2,974	5,187	36	267.3	8
London	0.44	26.6	1,730.3	141.4	8,353	8,655	27	166.4	10
Melbourne	0.26	7.6	890.0	49.4	675	3,253	28	229.4	3
New York	0.28	9.1	960.9	59.6	1,075	2,944	32	92.4	2
Oslo	0.56	15.6	1,543.8	91.3	2,186	6,174	31	594.9	14
Paris	0.48	24.3	1,379.8	71.3	3,397	3,002	32	149.5	7
Rome	0.67	34.0	1,741.4	100.1	5,585	5,214	24	230.0	13
Stockholm	0.43	20.8	1,801.0	125.2	3,632	7,610	35	456.6	13
Sydney	0.28	12.3	1,215.0	75.4	1,427	6,451	32	225.0	4
Wellington	0.15	7.6	1,520.4	42.3	930	2,151	33	289.3	6
Tel-Aviv	0.28	20.4	1,168.4	49.7	5,591	2,477	17	14.7	1
Average for all cities excluding Tel-Aviv	0.45	18.4	1,346.7	86.1	3,331.2	4,981	30	243.9	8

* From all motorized kilometers traveled.

Source: *Millennium Cities Database for Sustainable Transport, 1995*.